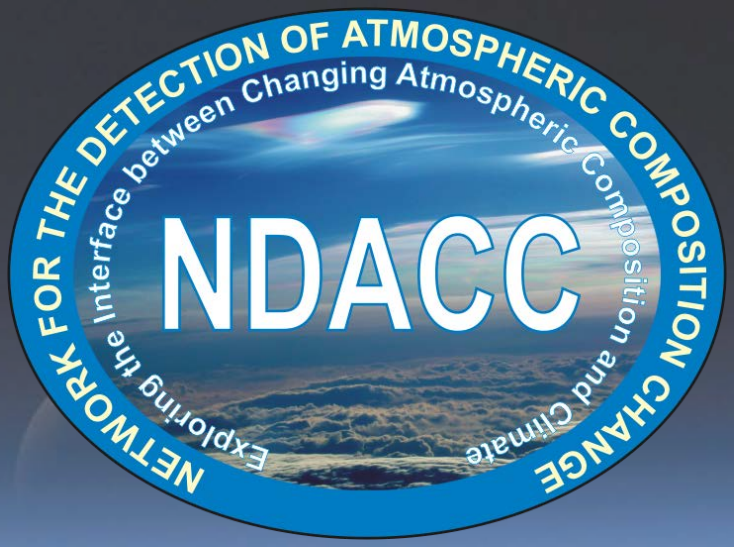

Network for the Detection of Atmospheric Composition Change

Update on a GRUAN Partnership

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Goddard Earth Sciences, Technology, and Research (USRA / GESTAR)

On behalf of the NDACC Science Team and Its Steering Committee and Co-Chairs
***Martine De Mazière** (BIRA-IASB) & **Anne Thompson** NASA GSFC)*

GRUAN ICM-8; Boulder, CO; April 25-29, 2016

Steering Committee

- Co-Chair
- Co-Chair
- Executive Secretary
- Working Group Representatives
- Peer, Ex Officio, Emeritus, and Cooperating Network Representatives

NDACC

Working Groups and Theme Groups

- Dobson & Brewer
- FTIR
- LIDAR
- Microwave
- Sondes
- Spectral UV
- UV-Visible
- Satellite
- Theory & Analysis
- Water Vapour
- Ozone
- Measurement Strategies & Emphases

Quality Assurance

Protocols

Data
Measurements
Instrument Validation and Intercomparisons
Theory and Analysis

Goals & Results

Long-term time series for detecting andunderstanding changes and trends in atmospheric composition and parameters

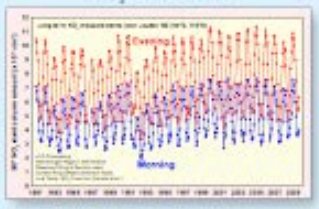
Establish scientific links and feedbacks between climate change and atmospheric composition

Satellite calibration, validation and gap-filling

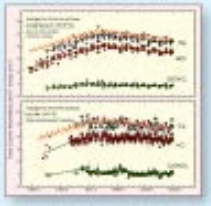
Collaborative support to scientific field campaigns and other chemistry and climate observing networks

Model validation and development support

NO_2 Slant Column



Inorganic Cl Column



Station Network

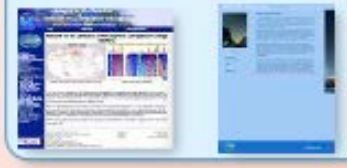
Cooperating Networks

ESRL/GMD/HATS
TCCON
BSRN
AERONET
MPLNET
GRUAN
SHADOZ
AGAGE

Outreach and Data Archiving

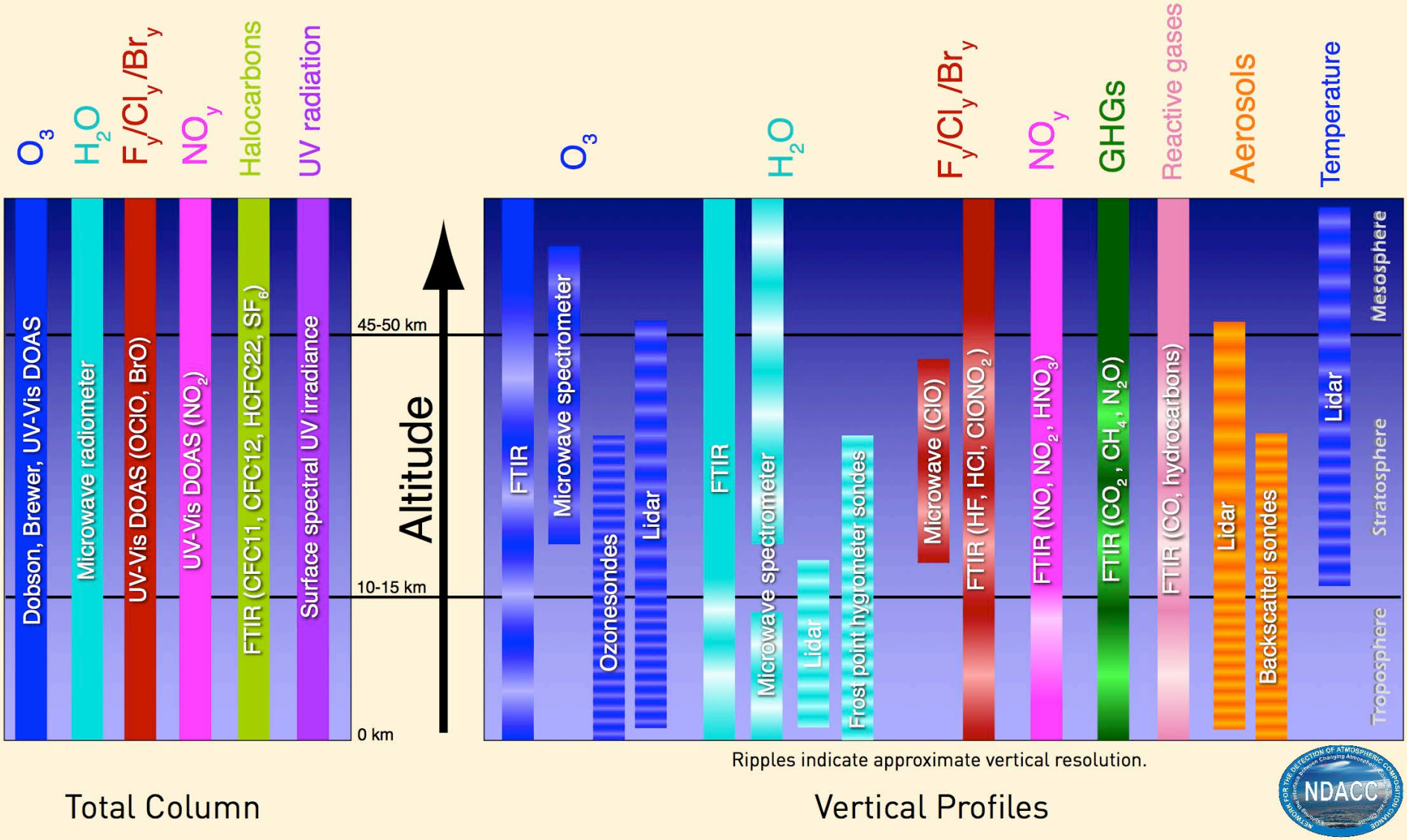
Data Host Facility

Web Sites



Newsletter
Brochure
Leaflet

Observational Capabilities of the Network for the Detection of Atmospheric Composition Change



Ripples indicate approximate vertical resolution.

Total Column

Vertical Profiles

Data Host Facility (DHF)

Issues for a Mature & Growing Network (J. Wild)

More than 125,000 data files are archived in the DHF

- Up-to-date archiving & availability of quality data are critical for
  - *continued international network recognition and data use*
  - *maintaining NDACC's identity in providing fiducial reference measurements for characterizing satellite observations*
- Revisions to the NDACC Data Protocol
  - *DHF submission of the verifiable product referred to as "NDACC Data" is reduced from 2 years to 1 year, with a corresponding shortening of the time scale for public release*
  - *formal PI and Institutional communications will be implemented to address archiving difficulties*
- DHF Improvements
  - *greater clarity regarding data file versions and data processing*
  - *more thorough data quality checks*
  - *dedicated directory for submission of Rapid Delivery Data*

Instrument Working Groups (IWGs) and Theme Groups (TGs)

Selected Highlights

The following charts summarize:

- *A few operational highlights that were presented at the October 2015 NDACC Steering Committee Meeting that are relevant to GRUAN*
- *Information from the IWGs that have a bearing on the "centralization" of data processing within NDACC*
  - *for NDACC, the first priority related to this issue focuses on the homogenization of data processing procedures within each instrument type*
  - *for some instruments the ultimate goal might be that a single center (not necessarily the DHF) processes all data from that instrument*

Theory & Analysis WG

(B.-M. Sinnhuber & S. Strahan)

- More proactive involvement with the Instrument WG's
  - *production of simulated station data using GMI-MERRA (categorized by instrument type: Dobson, FTIR, lidar, & sondes)*
    - *available via ftp from the NDACC archive* ftp://ftp.cpc.ncep.noaa.gov/ndacc/gmi_model_data/
  - *working to provide a better understanding of station data variability and representativeness (a bridge between individual stations and the global perspective)*
    - *a context for interpreting station observations*
  - *hindcast simulations also being conducted*
- Focused effort on model simulations to help set priorities for network expansion and/or instrument relocation
  - *will build upon GRUAN RP-4: Outcomes of the GRUAN Network Expansion Workshop*

Combining Trace Gas Data TG

(R. Prinn & S. Strahan)

- A research activity involving NDACC and several of its Cooperating Networks
  - *select a gas (such as CH_4) and a period where the participating networks have good quality data*
- Objectives
  - *do a combined data inversion, thereby increasing the estimation accuracy and assessing the value of each measurement type*
  - *combine results of data inversion study with an understanding of station data variability and representativeness (Theory and Analysis Working Group)*
  - *conduct Observation System Simulation Experiments (OSSE's) to assess the future measurement location, precision, accuracy, and temporal resolution needed to lower the uncertainty of trace gas budget estimations*

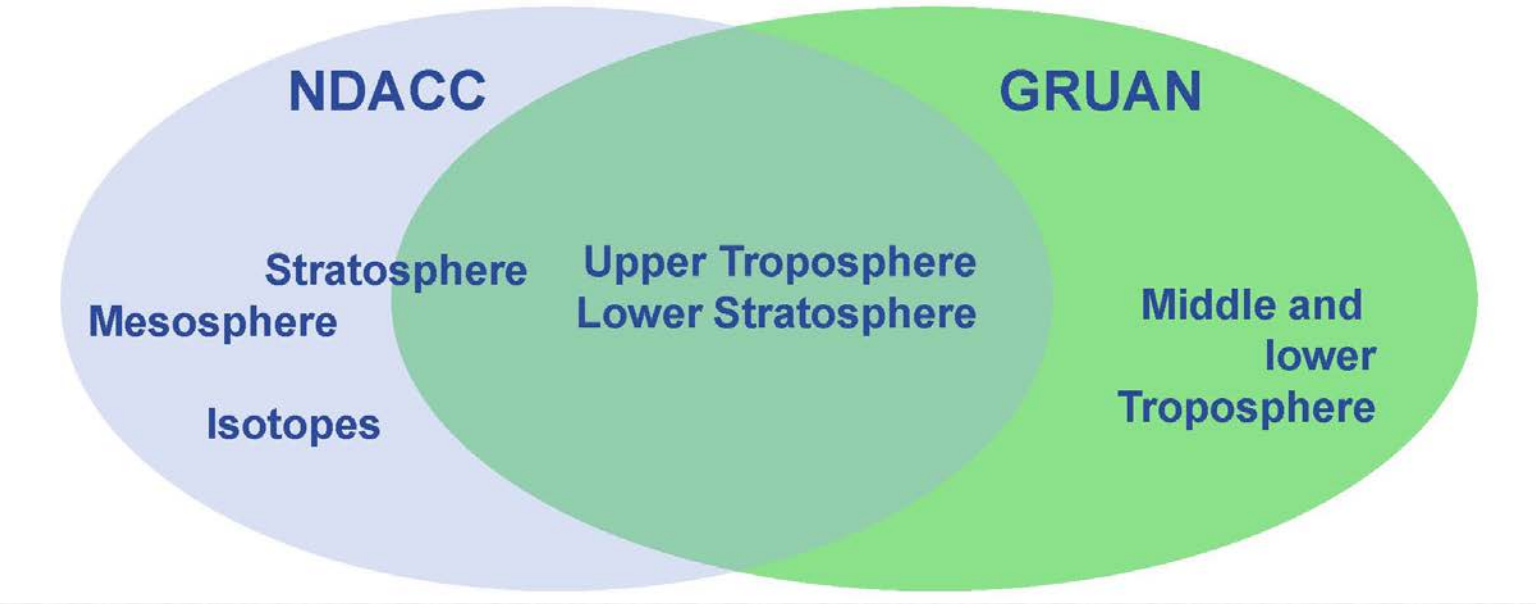
Water Vapor Measurement Strategy TG

(H. Vömel & D. Hurst)

- Development of a network-wide measurement strategy
  - *Theme Group represented by Vömel on the NDACC SC*
  - *strategy initially focused on frost point sondes (an accepted NDACC measurement capability – Hurst appointed as a new member of the Sonde Working Group)*
  - *Frost Point Sonde Appendix added to NDACC Validation Protocol*
  - *strategy expanded to coordinate all current NDACC water vapor measurements (lidar, microwave, FTIR, and frost point sondes)*
  - *recognizing that*
    - *these other NDACC instruments produce either integrated column values (precipitable water - typically describing only the first 6 km of the atmosphere) or low-resolution vertical profiles*
    - *high- resolution FPS profiles can be vertically averaged for comparison with the low-resolution profiles or integrated to compare with the column measurements*

Water Vapor Measurement Strategy TG
(continued)

- Strategic considerations
  - *instrument calibration / stability / intercomparisons, uncertainty documentation, data processing stability, traveling standards*
  - *observation frequency, geographic distribution*
- Cooperation with GRUAN is essential
  - *complete instrument duplication within NDACC and GRUAN probably not necessary; overlap in "climate-critical" region*



"Centralization" of Data Processing

Considerations

- An important matter for IWG consideration
  - *need to take into account various instrumental aspects and potential for algorithm harmonization for each instrument type*
    - *i.e., many instruments are unique PI-developments or modifications rather than OTS measurement technologies*
  - *engagement with international programs established to ensure measurement, analysis, and reporting consistencies*
- Positive Aspects
  - *unifies the treatment of data & alleviates PI burden (resources)*
    - *eliminates uncertainty in auxiliary information*
    - *preservation of instrument-specific parameters (continuity issues)*
    - *ensures that data are provided in a timely manner with well-documented traceability and quality*
    - *isolated PI processing can result in longer submission delays*
    - *may awaken an improved "network spirit"*
    - *possible expansion of Network coverage by certain instruments*
  - *could guarantee data delivery from key stations (e.g., for providing satellite, CAMS, etc. product validation)*

"Centralization" of Data Processing

Considerations (continued)

- Issues and Concerns
  - *agreement on single analysis package for each instrument type*
  - *dangerous potential of losing individual PI involvement with the scientific interpretation and reporting*
    - *possibly mitigated by feedbacks between processing center & PI*
    - *PI processing results in high quality data for research purposes*
    - *centralized processing may not result in the highest quality data*
  - *NDACC DHF does not have the resources to store level 0 data or to provide processing for all NDACC data*
    - *processing costs are not eliminated by transferring responsibility (e.g., WOUDC no longer supporting centralized Umkehr processing)*
  - *requires additional level of coordination between data centers*
  - *requires consistent PI transmission of all metadata*
- Path(s) forward
  - *continue WG efforts on homogenization of reporting & processing*
  - *explore aspects of co-processing involving PIs and a central facility as well as possible coordination of processing within a WG*

"Centralization" of Data Processing

Considerations (continued)

- Quality assurance of measurements and analyses fostered through the Instrument WGs
  - *agreed upon SOPs*
  - *use of "common" algorithms*
  - *use of like spectral parameters where applicable*
  - *calibration aspects*
  - *uncertainty expressions*
  - *recommended resolutions for profiles*
  - *use of common data formats to better assist processing*
  - *interfaces with the NDACC Theory and Analysis Group*
- Ongoing GAIA-CLIM activity on identifying the maturity and quality of NDACC data
  - *by assessable attributes, such as traceability, documentation, metadata retention, uncertainty quantification, etc. thereby providing reference grade products*

Dobson/Brewer WG

(I. Petropavlovskikh & V. Savastiouk)

- Data reprocessing
  - *15 NOAA operational Dobson stations using new WinDobson software by the end of 2016; discontinued data sets to follow*
  - *comparison of reprocessed data with historical datasets archived at WOUDC & NDACC; reconciliation of differences followed by re-archival of data*
  - *validation of reprocessed data (satellite & ground-based at stations with co-located measurements)*
  - *Brewer data reprocessing under EUBrewNet*
- Use of calibration series and model outputs for
  - *identifying and correcting instrumental drifts*
  - *tracking instrumental changes and assessing short and long-term impacts of temperature corrections on Dobson records*

Dobson/Brewer WG

(continued)

- Improved calibration, characterization, and traceability of column ozone instruments
  - *cooperation with ECCC for understanding the traceability of Brewer network calibrations and avoiding two different total ozone references*
  - *EUBrewNet coordination of Brewer measurements*
    - *standardization of calibration protocols*
    - *standardization of instrument characterization methods*
  - *comparison of Dobson, Brewer, Pandora, & Phaeton in Izaña under EMRP59 ATMOZ*
  - *evaluation of Pandora as a potential Dobson replacement*
- Comparisons between Dobson, Brewer, ozone-sonde and satellite-derived total ozone measurements at South Pole
  - *determination of the stray light in Dobson measurements at the low sun conditions*

FTIR WG

(T. Blumenstock & J. Hannigan)

- More than 20 FTIR sites operated worldwide
  - *centralized processing to be discussed at the next IRWG meeting*
- PIs manage their own data; consistency achieved through
  - *Operations*
    - *use of standard optical filter sets at each measurement site*
    - *centralized calibration verification via new HBr & N_2O cells*
  - *Analyses*
    - *Network use of HITRAN 2008 species line list (implementation of revised active line lists is a future possibility)*
    - *use of common retrieval packages (SFIT4 & PROFFIT)*
    - *data quality checks prior to DHF submission for proper altitude grids, error estimates, etc.*
- Harmonization and characterization of data sets
  - *CO time series in support of satellite validation (EU QA4ECV project)*
  - *traceability and harmonized uncertainties for O_3, H_2O, & CH_4 products (EU GAIA-CLIM project)*
  - *harmonized retrieval strategy for NO_2 & HCHO time series (NIDFORVal)*

FTIR WG
(continued)

- Increased emphases on partial column & profile retrievals
  - *participation in the Tropospheric Ozone Assessment Report (TOAR), an IGAC project focused on the global distribution and trends of O_3 from the surface to the tropopause*
- Development of a small FTIR for GHG measurements
  - *comparisons of CH_4 and CO_2 measurements with TCCON*
- Development of an FTIR Technical Document for GRUAN

Lidar WG

(T. Leblanc & W. Steinbrecht)

- Importance of a mobile lidar "traveling standard"
- ISSI project: definition of vertical resolution and definitions /approaches for treating uncertainties in O_3 and T retrievals
  - *goal of consistent implementation by all O_3 and T lidar PIs*
- New T and H_2O retrieval algorithms for characterizing systematic and random uncertainties
  - *optimal estimation methods for water vapor retrievals*
- Rigorous measurement intercomparisons
  - *with various instrument types, including satellites*
- Validation of meteorological analyses
  - *ARISE project (stratospheric & mesospheric temperatures)*
    - *gravity waves, planetary waves, stratospheric warmings, etc.*
- Ongoing work on LidarRunClient for GRUAN
  - *noting that each lidar measurement is different*

Microwave WG

(N. Kämpfer & G. Nedoluha)

- Participation of 6 NDACC water vapor instruments in the SPARC WAVAS-II assessment
- Total standardization of measurements and retrieval algorithms is very difficult
  - *instruments are individually built and have distinctly different characteristics; newer instruments operate differently from older existing ones*
  - *calibration procedures differ for species (O_3 vs. H_2O vs. ClO)*
  - *retrieval algorithms tailored to primary altitude of interest, integration times, weight of a priori information, etc.*
  - *however, almost everyone uses optimal estimation, which guarantees that they are "speaking the same language"*

Microwave WG
(continued)

- Two forward models are used and give similar results
  - *Atmospheric Radiative Transfer Simulator, ARTS, (European development and present standard for microwave radiative transfer in the middle atmosphere) and the NRL developed "Meta" (US)*
- Traceability chain for microwave radiometers established under GAIA-CLIM
  - *detailing the process of producing a geophysical product from the instrument measurements*
- Calibration standardization has hope for improvement
  - *characterization of black body targets*
- Centralized processing of the eight microwave instruments operated by NRL is a goal

Sonde WG – Ozone

(B. Johnson & R. Stübi)

- Large number of globally distributed measurements offer excellent intercomparison opportunities with various instrument types for measurement quality assurance
  - *27 active NDACC sites (~1500 profiles / year)*
  - *comparisons with lidars for tropospheric O_3 trends*
- Data homogenization achieved through the O3S-DQA
  - *originally part of SI²N Assessment, but timeline was delayed*
  - *documentation of homogenization process and quantification of sounding uncertainties (goal of reducing uncertainties to 5-10%)*
  - *September 2016 "ozonesonde experts" workshop scheduled*
    - *work towards achieving uniformity of procedures and processing*
    - *discussions of central data processing are likely together with harmonization of data records*
- Data processing currently described in the data file header
  - *enables the user to check and/or reprocess the data*

Sonde WG – Ozone

(continued)

- Continuing evolution and implementation of SOP's
  - *provides guidelines for deriving uncertainties*
  - *2017/18 JOSIE Campaign being planned with SHADOZ*
- Several sites have their own data-editing software
  - *allows for quick editing and near-real-time data updates*
- SHADOZ exemplifies many of the difficulties
  - *2 manufacturers, 4 solution strengths, 6 radiosonde & ground stations producing different file formats, 11 different SOP's*
  - *working with stations to*
    - *improve SOP's*
    - *provide best practice guidelines (sometimes beyond WMO/JOSIE)*
    - *provide processing support*
    - *adopt WMO/GAW standards*
  - *completed a major data reprocessing in 2015 (NASA/GSFC, NOAA, NCAR, + individual site PI's)*

Sonde WG – Water Vapor

(D. Hurst & H. Vömel)

- Sonde WG now includes ozone, aerosols, & water vapor
- Water vapor sondes currently launched at 7 NDACC sites
  - *NOAA FPH data from Boulder, Hilo, & Lauder processed by Hurst*
  - *CFH data from Ny Ålesund, Sodankyla, Lindenberg, & Costa Rica processed by Vömel*
  - *little difference in outputs from the two analysis packages*
- Data processing standardization is a work in progress
  - *paper drafted on CFH measurement uncertainties*
    - *likely applicable to FPH*
    - *may help in development of a GRUAN data product*
  - *dual processing likely to continue for the NDACC data product*
    - *will follow GRUAN developments / decisions (analysis software, centralization of processing, uncertainty analysis, etc.)*

UV/Visible WG

(K. Kreher & M. Van Roozendael)

- >30 UV-Vis. spectrometers operated worldwide
  - ~10 research institutions and University laboratories
  - *>2 decades of DOAS total O_3, NO_2, BrO, & OClO column amounts*
- WG provides data evaluation and analysis tools, quality assessment procedures, and operational recommendations
  - *regular instrument and algorithm intercomparisons*
    - *MAX-DOAS intercomparison (CINDI2) in Cabauw, (Sept. 2016)*
  - *development of generic DOAS retrieval software*
    - *ensuring long-term data quality and consistency*
    - *fostering harmonization of network data series*
- New WG focus on Max DOAS VCD and profile measurements (NO_2,HCHO, BrO, CHOCHO, aerosols)
  - *NIDFORVal project, joint with FTIR, for Sentinel-5P validation*
    - *harmonized retrieval strategy for NO_2 & HCHO time series*

UV/Visible WG
(continued)

- MAXDOAS data harmonization through EU QA4ECV
  - *data acquisition, retrieval methods, error analysis, etc.*
- Prototype system for MAXDOAS centralized processing through ESA FRM4DOAS project (satellite validation)
- GAIA-CLIM Project –traceability of O_3 retrieval methods
  - *characterization of satellite observations of ECV's using high-quality ground-based data sets*
- Operational use of NDACC data for contributing to CAMS validation demonstrated in the EU FP7 NORS project
  - *rapid delivery of harmonized data*
- Evaluations of new instruments (mini-SAOZ and Pandora)
  - *intercomparisons of both with Dobson, etc. ongoing*
  - *Russian Roshhydromet Ozone Network (6 mini-SAOZ + 2 Brewers + 1 Dobson); full operation expected in 2016*

Spectral UV WG

(G. Bernhard & G. Seckmeyer)

- Five instrument types are used within NDACC
  - *Biospherical Instruments SUV-100 and SUV-150 spectroradiometers at Summit, Barrow, Palmer, Arrival Heights and South Pole*
  - *Bentham DTM300 spectroradiometers at Boulder, Mauna Loa, Alice Springs, and Lauder*
  - *Bentham DM150 spectroradiometers at Sonnblick and Groß-Enzersdorf*
  - *Bentham DTMc300 spectroradiometers (replacing Jobin-Yvon HD10 spectroradiometers) at Briançon, Villeneuve d'Ascq, and La Réunion*
  - *Bentham DTM300 spectroradiometer in Hannover, Germany is used for intercomparisons (as travelling standard)*
  - *the use of Brewer spectrophotometers is a consideration for the future*
- Data processing within these five groups is not centralized because hardware, data formats, and required correction schemes are different
  - *presently there are no plans for fully centralized processing of all spectral UV measurements contributing to NDACC*

Other News

NDACC Special Journal(s) Issue

- Commemorating 25 years of global atmospheric research enabled / enhanced by NDACC/NDSC observations
- Joint special issue
  - *3 Journals (Earth System Science Data, Atmospheric Chemistry and Physics, and Atmospheric Measurement Techniques)*
  - *7 international scientists have agreed to serve as Co-Editors*
- More than 54 publications have been "registered" to date
  - *an opportunity for joint publications between NDACC and its Cooperating Networks*

NDACC Web Site Re-design

- Easier access to measurement and model data
- www.ndacc.org

The NDACC Steering Committee and Science Team look forward to continuing our productive relationship with GRUAN.

We welcome comments and suggestions by GRUAN leadership for enhancing this relationship.

Thank you!